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[54] CELLULAR COMMUNICATIONS SYSTEM
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58-164007 6/1983 Japan .[75] Inventors: Larry G. Fischer, Waseca, Minn.;
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[52] U.S. Cl. 379/56.2; 455/562; 359/152

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379/56.1, 56.2; 455/33.1, 33.2, 33.3, 33.4,
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[56] References Cited

U.S. PATENT DOCUMENTS

4,144,409 3/1979 Utano et al. 179/2
4,144,411 3/1979 Frenkiel .

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

2008900 1/1990 Canada .
2 345 865 3/1977 European Pat. Off. .
0 166 885 4/1985 European Pat. Off. .
0 346 925 6/1989 European Pat. Off. .
0 368 673 11/1989 European Pat. Off. .
0 391 597 3/1990 European Pat. Off. .
0 468 688 A2 7/1991 European Pat. Off. .

OTHER PUBLICATIONS

City Cell, Cellular Industry The Day Group, "ADC Kentrox
CityCell Field Trial Yields Another First: Simultaneous
Analog and Digital Calls," (1 page).

(List continued on next page.)

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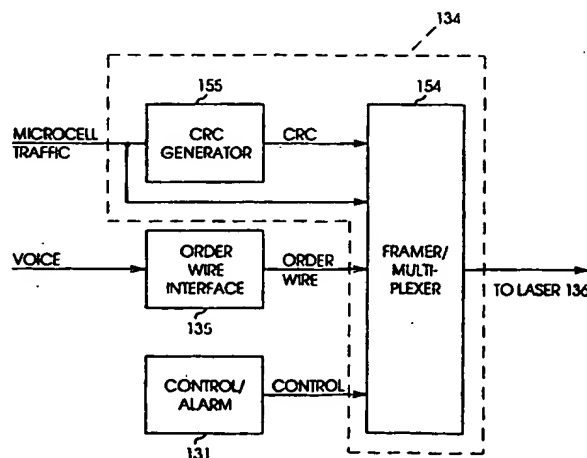
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[57] ABSTRACT

A method and apparatus for sectorizing coverage of a cellular communications area includes providing a remote unit having microcell antenna units. Each microcell antenna unit is configured to cover a particular sector. The remote unit is connected to a sectorized base station unit which is connected to a mobile telecommunications switching office. Separate digitized streams representative of telephone signals received from the mobile telecommunications switching office are generated corresponding to the microcell antenna units and the separate digitized streams are multiplexed and transmitted to the remote unit. The remote unit demultiplexes the multiplexed digitized streams into the separate digitized streams corresponding to the microcell antenna units and the separate digitized streams are converted to RF signals for coverage of a particular sector by the corresponding microcell antenna unit. Separate digitized streams are separately generated for each microcell antenna unit representative of RF signals received at the microcell antenna unit for a particular sector. The separately generated digitized streams are multiplexed at the remote unit and transmitted to the sectorized base station unit. At the sectorized base station unit, the multiplexed digitized streams are demultiplexed into the separate digitized streams corresponding to microcell antenna units and the separate digitized streams are converted to RF signals for provision to the mobile telecommunications switching office. Diversity at the remote units is also provided.

9 Claims, 58 Drawing Sheets



U.S. PATENT DOCUMENTS

4,231,116	10/1980	Sekiguchi et al.	
4,451,699	5/1984	Gruenberg	
4,456,793	6/1984	Baker et al.	
4,475,010	10/1984	Huensch et al.	
4,485,486	11/1984	Webb	
4,525,861	7/1985	Freeburg	
4,556,760	12/1985	Goldman	
4,613,990	9/1986	Halpern	
4,669,107	5/1987	Eriksson-Lennartsson	
4,759,051	7/1988	Han	
4,790,000	12/1988	Kinosita	
4,797,947	1/1989	Labadz	
4,831,662	5/1989	Kuhn	359/156
4,916,460	4/1990	Powell	
4,932,049	6/1990	Lee	
5,067,147	11/1991	Lee	
5,067,173	11/1991	Gordon et al.	359/152
5,084,869	1/1992	Russell	
5,159,479	10/1992	Takagi	
5,175,867	12/1992	Wejke et al.	
5,193,109	3/1993	Chien-Yeh Lee	379/60
5,243,598	9/1993	Lee	
5,251,053	10/1993	Heidemann	
5,267,261	11/1993	Blakeney, II et al.	
5,278,690	1/1994	Vella-Coleiro	
5,280,472	1/1994	Gilhausen et al.	
5,285,469	2/1994	Vanderpool	
5,297,193	3/1994	Bouix et al.	379/63
5,301,056	4/1994	O'Neill	
5,303,287	4/1994	Laborde	
5,305,308	4/1994	English et al.	
5,309,474	5/1994	Gilhausen et al.	
5,339,184	8/1994	Tang	359/124
5,381,459	1/1995	Lappington	379/56
5,392,453	2/1995	Gudmundson et al.	455/33.2

OTHER PUBLICATIONS

A Two-Way Wavelength-Division-Multiplexing Transmission and its Application to a Switched TV Distribution System, Electrical Communication Laboratories, Nippon Telegraph & Telephone Public Corporation, Yokosuka, Japan and Technical Bureau, Nippon Telegraph & Telephone Public Corporation, Tokyo, Japan, Hideki Ishio, et al. (10 pages).

Microwaves & RF, Mar. 1993, "Offshore Markets Gain in Size, Competitiveness, Even the smallest industry companies are expanding their global business, despite such costly distractions as ISO 9000." (1 page).

"New Signal Transport Technology Digitizes The Cellular Band" Cellular Industry—The Day Group.

"Kentrox boosts coverage and capacity" Steven Titch, News Editor, Telephony/Jan. 25, 1993.

"New Microcell Technology Sets Cellular Carriers Free", David Russell, Telephony Mar. 1993.

"ADC Kentrox Introduces CityCell 824, A Replacement For conventional Cell Sites; Company's Original Goal Was To Improve Fiber Optic T1 Links Between Cells, MTSOs", Telocator Bulletin, Feb. 1993.

"Digital transport for cellular", Microwaves & RF, Feb. 1993.

ADC Kentrox Wireless System Group CityCell™ 824—A positioning white paper. (Mar. 1993) CITIA Trade Show.

Broadband Optical Transport Digital Microcell Connection Service—Interface and Performance Specifications. A technical description of the User-Network Interface and performance specification for Amaurotic Digital Microcell Connection Service. To: Amaurotic and Vendor Community. AM TR-NIS 000117. Issue 1, Dec. 1993.

ZoneMaster—Maximum Coverage for High-Capacity Locations. Decibel Multi-MicroCell Systems (Feb. 1993).

Personal Wireless. Special Report/Communications, IEEE Spectrum (Jun. 1993).

Fiber Optic Antenna Remoting for Multi-Sector Cellular Cell Sites. Douglas D. Tang GTE Laboratories—Abstract (Conference Jun. 14–18, 1992).

Urban Microcell System Layout. GTE Laboratories (Conference Jun. 14–18, 1992).

A Radio System Proposal Widespread Low-Power Tetherless Communication, Donald C. Cox, IEEE, vol. 290, No. 2 (Feb., 1991), pp. 328–329.

Land Mobile Radio Systems—A Tutorial Exposition, S.C. Gupta, IEEE, vol. 23 No. 6, (Jun. 1985) pp. 34–41.

Prof. R. Steele, B.Sc., Ph.D., D.Sc., C. Eng., Sen. Mem. I.E.E.E., M.I.E.E. Towards a High Capacity Digital Cellular Mobile Radio System, IEEE Proceedings, vol. 132, Pt.F, No. 5, Aug. 1985.

ZoneMaster™—Maximum Coverage For High-Capacity Locations. Decibel Multi Media MicroCell System. Four pages. 1993 Decibel Products. 2–83–5M.

"And now a few words from your Customers. . ." Four pages. ADC Kentrox® A Subsidiary of ADC Telecommunications, Inc. Aug. 1992 –4069.

New Release—First Field Trail Results Exceeds Expectations (Mar. 2, 1993).

News Release—"ADC Kentrox Introduces Innovative Wireless Network Access Solution" (Mar. 1, 1993).

41st IEEE Vehicular Technology Conference, May 19–22, 1991, Gateway to the Future Technology, 91CH2944–7, British Telecom Research Laboratories, R P Merrett, A J Cooper & IC Symington, "A Cordless Access System Using Radio-Over-Fibre Techniques," pp. 921–924.

1993 43rd IEEE Vehicular Technology Conference, May 18–20, 1993, Personal Communication—Freedom Through Wireless Technology, Waseca Technology Inc., Philip M. Wala, published May 18, 1993, "A New Microcell Architecture Using Digital Optical Transport," pp. 585–588.

1993 43rd IEEE Vehicular Technology Conference, May 18–20, 1993, Personal Communication—Freedom Through Wireless Technology, PacTel Corporation, W.C.Y. Lee, Terry Benz, Ron Rudokas, published May 18, 1993, "Intelligent Microcell Applications In PCS," pp. 722–725.

Vehicular Technology Society 42nd VTS Conference Frontiers of Technology, From Pioneers to the 21st Century, GTE Laboratories Incorporated, Vincent O'Byrne, "TDMA and CDMA in a Fiber-Optic Environment," vol. 2 of 2, pp. 727–731. (May 10, 1992).